

STATUS REPORT NO. 7
On Vacuum UV Study of Solids

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Title of Research: Theoretical and experimental investigations
of electron emission, conductivity and
luminescence of selected solids under
vacuum UV radiation.
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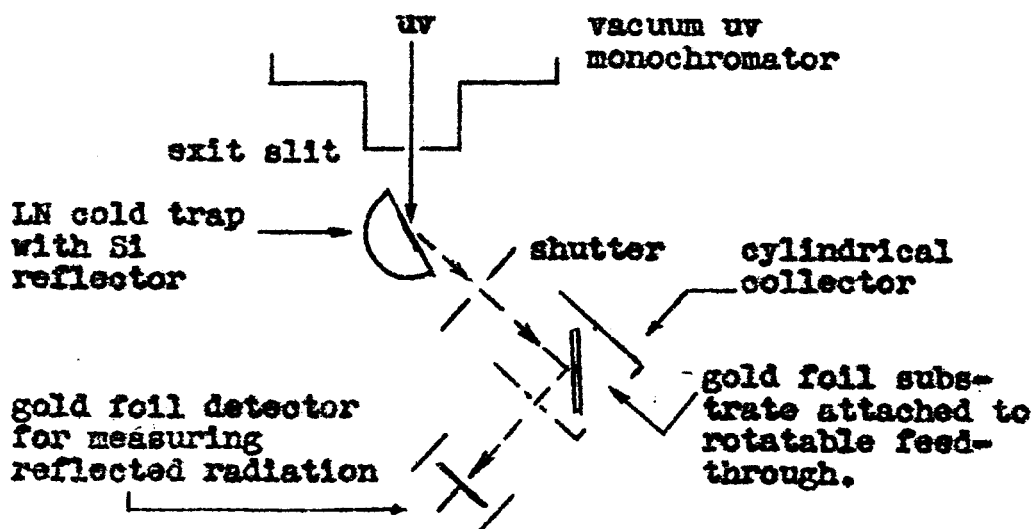
A. Summary of Progress (6-month period)

- a. A publication entitled Attenuation Length Measurements of Photoexcited Electrons in CuBr Films will appear in the Journal of Applied Physics.
- b. Spectral quantum yield measurements on evaporated layers of cuprous halides were made over the photon energy range of 10 to 23 eV.
- c. Backward photoemission yield of evaporated KBr was measured as a function of thickness. Similar experiments were also performed on evaporated films of tellurium and aluminum.
- d. Photoemission-yield and optical density measurements were made on evaporated layers of mixed system KCl-KBr.
- e. Photoionization-yield measurements on Nitric Oxide were made in the photon energy range from 10 to 21 eV.

B. Brief Description of Research and Results

- I. Photoemission measurements on evaporated layers in the photon energy range from 10 to 23 eV.

In order to avoid the possibility of contaminating the photoemissive surface by diffusion-pump oil vapor from the monochromator, a cold trap with a polished Si crystal reflector was mounted near the exit slit. The photocell chamber in which photoemission was measured is shown in the following diagram.



The photocell chamber was evacuated by a 80 L/s ion pump. The photoemissive layer was deposited on the gold substrate by evaporation. Measurements were made after evaporation without breaking the vacuum. The spectral quantum yield at 45° angle of incidence was obtained by comparing the photoemission current

of the evaporated layer with that of a gold foil. The relative yield of gold was measured over the range of 10 to 23 eV by comparing the emission current with the luminescent response of sodium salicylate. The absolute yield in this range was determined on the basis of the calibrated yield of gold in a clean vacuum at 10.2 eV. The calibration was performed with a thermocouple radiation detector.

The results of our measurements on cuprous halides show that the spectral quantum yield (corrected for reflectivity at 450) increase with $h\nu$ above 10 eV and reach a plateau which extends from about 12 eV to the energy limit of our measurements. For example, the yield of CuI from 12 to 23 eV is approximately $(15 \pm 3)\%$.

II. Attenuation Length Measurements in the Photon Energy Range of 7.8 to 11 eV.

As described in a previous status report (no. 6), the attenuation length or the escape depth of the photoemitted electrons from a thin film can be determined by measuring the backward photoemission yield as a function of thickness. A publication concerning such measurements on CuBr films will appear in the Journal of Applied Physics.

Similar experiments have been performed on evaporated films of potassium bromide, tellurium, and aluminum. The results show that the attenuation lengths of the photoexcited electrons at $h\nu = 10.2$ eV are approximately 180 Å, 60 Å, and 20 Å for KBr, Te, and Al, respectively. For KBr the attenuation length is longer than the absorption depth for the photons. This result is consistent with the fact that KBr has relatively high yield.

In addition, the forward photoemission yield of KBr was measured as a function of thickness. The yield curves from these measurements appear to saturate at about 250 Å, in fair agreement with the measured attenuation length. It should be mentioned that additional increase in yield beyond 250 Å was observed for $h\nu > 10$ eV. Further measurements of forward emission yield as a function of thickness are required to clarify this unexpected result.

III. Photoemission from Mixed System KCl-KBr

Measurements of photoemission yield and optical density of evaporated mixture of KCl-KBr were made. A 50-50% mixture was first fused in a quartz boat at atmospheric pressure. Then the mixture was placed in the vacuum chamber, and a film of mixture was deposited on a substrate. A LiF substrate was used for the optical density measurements. The optical density curve agrees with the data of Mahr (Phys. Rev. 122, 1464 (1961)).

The photoemission yield curve shows a steep rise at 8.3 eV. The yield at 11 eV is about 40%. The effective photoemission threshold of 50-50% mixture of KCl-KBr appears to be about 0.3 eV higher than that of pure KBr.

IV. Photoionization Yield of Nitric Oxide

Measurement of photoionization yield of nitric oxide was extended to the region 584-900 Å by using the He₂ continuum source and a one-meter monochromator. The resolution was about 0.3 Å. Xenon gas was used as reference for absolute intensity measurement. Data reduction has been completed.

C. Plans for Next Period

- a. Further measurements on photoemission yield as a function of thickness will be performed.
- b. Transmittance measurements on evaporated layers in the photon energy range of 10 to 23 eV will be made.
- c. Attempts will be made to measure energy distribution of photoemitted electrons.
- d. Further studies on photoconductivity in solids under vacuum uv excitation will be made.
- e. A paper on the photoionization yield of nitric oxide will be prepared for publication.

D. Personnel

The following persons participated in this research during the past six months:

William Pong, Associate Professor, full time during summer, otherwise about 1/3 time.

K. Watanabe, Professor, half-time during summer, otherwise about 1/4 time.

G. Yokotake, Jr. Specialist, 1/5 time for one month.

K. Sumida, Graduate Assistant, 3 months.

L. Lum, undergraduate, Lab. Assistant on part-time basis.